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(दूसरा पुनरीक्षण)

Automotive Vehicles — Air Conditioning and Heating Systems Thermal Performance — Method of Measurement

(Second Revision)

ICS 43.040.60; 19.060

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Refrigeration and Air Conditioning Sectional Committee, MED 03

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Refrigeration and Air Conditioning Sectional Committee had been approved by the Mechanical Engineering Division Council.

This standard was first published in 1999 and subsequently revised in 2013.

Majority of passenger vehicles are provided with occupant comfort control systems, such as, heating, ventilation, and air-conditioning systems (HVACS). The manufacturers of automotive air conditioning systems have their own discreet procedure for assessment of the performance of the air conditioning system. This standard aims at standardization of the method for evaluation of air conditioning system performance of different types and categories of vehicles.

This revision has been taken up to update the standard based on latest technologies. The major changes in this standard are as follows:

a) The title and the scope have been revised;
b) Vehicles of *N1, N2,* and *N3* category have also been covered in addition to the vehicles of *M1* and *M2* category;
c) Pre-requirements for cooling test are modified;
d) Pre-requirements for heating test are added;
e) Performance evaluation is modified;
f) Cool down test is revised; and
g) Heating test is added.

The composition of the Committee responsible for the formulation of this standard is given in Annex C.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

AUTOMOTIVE VEHICLES — AIR CONDITIONING AND HEATING SYSTEMS THERMAL PERFORMANCE — METHOD OF MEASUREMENT

(Second Revision)

1 SCOPE

1.1 This standard covers the procedure for evaluating cabin cooling and heating performance of an automotive air conditioning and heating system and its compatibility with the engine.

1.2 This standard is applicable to vehicles of *M1*, *M2*, *N1*, *N2*, and *N3* category as per IS 14272 provided with air conditioning and heating systems based on vapor compression refrigeration cycle drawing power from the vehicle engine.

1.3 This standard does not apply to such automotive vehicles which are provided with a completely independent prime mover for the air conditioning system.

2 REFERENCES

The following standard contain provision which through reference in this text, constitute provision of the standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below:

IS No.	*Title*
14272 : 2011	Automotive vehicles — Types — Terminology (*first revision*)

3 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply.

3.1 Receiver Drier — The hollow tank in the refrigerant flow circuit separate or integrated with condenser catering to the surges of refrigerant flow which occur due to unpredictable changes in compressor speed and heat load variations. This generally incorporates a hygroscopic material for absorbing any moisture in the refrigerant.

3.2 Air Conditioning System — The system consisting of a cooling coil, compressor, condensing coil, condenser cooling fan/radiator cooling fan blower, receiver drier, expansion device, associated controls, plumbing and also refrigerant.

3.3 Blower — The air delivery fan used to circulate the air from the occupants' space (recirculated air) or from outside the occupants' space (fresh air) through the cooling/heating coil.

3.4 Compressor — The mechanical pump used to raise the pressure of the refrigerant and maintain flow of the refrigerant in the circuit.

3.5 Condensing Coil — The heat exchanger in which the heat from the refrigerant is transferred to the ambient air.

3.6 Cooling Coil — The heat exchanger through which the refrigerant evaporates and absorbs heat from the air (recirculation/fresh air mode) in the vehicle occupants space resulting in cooling the occupant area.

3.7 Discharge Pressure — The pressure of the refrigerant on the discharge side of the circuit.

3.8 Discharge Side — The high- pressure side of the refrigerant circuit. This is effectively from the exit of the compressor to the inlet of the expansion (or throttling) device.

3.9 Expansion Device — The device at which the high-pressure refrigerant is isenthalpically throttled down to lower pressure. This may be in the form of an internally or externally equalized thermostatic expansion valve.

3.10 Refrigerant — The medium which circulates inside the air conditioning system, that is, through the cooling coil, compressor, condensing coil and the related plumbing by absorbing heat at the cooling coil and rejecting it at the condensing coil.

NOTE — The refrigerants generally used are 1,1,1,2 tetra fluoro ethane (also called HFC-134a or R-134a) or HFO 1234yf.

3.11 Suction Pressure — The pressure of the refrigerant on the suction side of the circuit.

3.12 Suction Side — The low-pressure side of the refrigerant circuit. This is effectively from the exit of the expansion (or throttling) device up to the inlet of the compressor.

3.13 Heating Coil — The heat exchanger through which the heating fluid (engine coolant in general) rejects heat to the vehicle occupant's space resulting in heating the occupant area.

4 PREPARATION OF THE VEHICLE

4.1 Prior to the start of testing related to cooling, the following shall be ensured:

a) Air conditioning system of the vehicle shall be charged with the refrigerant to the mass specified by vehicle manufacturer;
b) Battery of the vehicle (or any alternate electrical power source) on which the various electrical components of the air conditioning system depend, shall be at rated voltage or as recommended by manufacturer throughout the test;
c) Vehicle should be of production intended configuration;
d) All cool air outlets shall be adjusted to direct the air flow towards the occupant's chest/face;
e) Blower shall be operating at its maximum air discharge;
f) Cooling intensity setting provided, if any, for the air conditioning system shall be set at its maximum intensity; and
g) Fresh air mode, if provided, shall be kept closed during the tests.

4.2 Prior to the start of testing related to heating, the following shall be ensured:

a) Before the start of test, the heating system of the vehicle may be properly de-aerated if recommended by manufacturer;
b) The battery of the vehicle (or any alternate electrical power source) on which the various electrical components of the air conditioning and heating system depend, shall be at rated voltage or as recommended by manufacturer throughout the test;
c) Vehicle should be of production intended configuration;
d) Air outlet settings shall be adjusted to direct the air flow towards the occupant's feet;
e) The blower shall be operating at its maximum air discharge;
f) Maximum hot setting provided if any, for the heating system shall be set at maximum intensity; and
g) Fresh air mode (if provided) shall be selected during the tests.

5 PERFORMANCE EVALUATION

The following tests shall be conducted on the vehicle to assess the cooling and heating performance of the air conditioning system:

a) Cool down test (*see* **5.1**); and
b) Heating test (*see* **5.2**)

5.1 Cool Down Test

This test is carried out to obtain the cabin temperature variation under steady state operation of the air conditioning system.

5.1.1 *Vehicle Preparation*

Sensors, such as, thermocouples for recording temperatures at nose levels of all occupant seating positions shall be fitted with recording instruments having an accuracy of ± 1 °C.

5.1.2 *Test Location*

Test shall be carried out either in a climatic chamber with controlled conditions or on road as per the test cycle mentioned in Annex A.

Test location for on road test to meet the required test conditions as mentioned in Annex A.

5.1.3 *Test Cycle*

Test cycle as mentioned in Annex A is to be followed.

5.1.4 *Vehicle Setup for Climatic Chamber Test*

The vehicle setup shall be done as follows:

a) Vehicle shall be parked in a climatic chamber at conditions mentioned as per Table 1 of Annex A with all doors and windows open;
b) Driver and co-driver seat setting:
    1) Back rest of seat shall be back one notch from vertical; or
    2) Arm rest shall be down.
c) Vent positions: As suggested by manufacturer;
d) Vehicle should be kept inside climatic chamber with doors and windows open. Set chamber temperature as per Annex A. Once the required temperature is achieved inside climatic chamber vehicle shall be soaked for at least 15 min to equalize the temperatures inside vehicle; and
e) After above step, all door and windows of vehicle shall be closed and solar load lamps to be started as per mentioned environment conditions.

5.1.5 *Vehicle Setup for Road test*

The vehicle setup shall be done as follows:

a) The vehicle shall be parked under direct sunlight in an open area free from structures which may cast shadows on any part of the vehicle; and
b) Soaking — The vehicle shall be positioned in such a way to ensure maximum solar load through the

windscreen and the side glasses during the entire duration of soaking as mentioned in Annex A. All the doors and windows of the vehicle shall be shut; this marks the start of soaking.

5.1.6 *Testing*

5.1.6.1 *Initial recording*

Initial temperatures at all the occupants nose/face level shall be recorded just before occupant entry.

5.1.6.2 *Start of test*

After the soaking period as mentioned in Annex A, the testing personnel shall enter the vehicle. For road test the total number of occupants during the test shall be not less than two in case of *M1*,*N1*,*N2* and *N3* and three for *M2* and in no case exceed the maximum seating capacity of the vehicle. While entering the vehicle, care shall be taken for the following:

Occupants shall enter one at a time. Each one shall enter quickly and shut the door behind immediately and not more than one door of the vehicle shall be opened at one time during entry.

5.1.6.3 *Running*

The vehicle shall be started and immediately the air conditioning system shall be switched on and the controls are set as mentioned in **4.1** c) to **4.1** f). The vehicle shall be driven as per the test conditions specified in Annex A. The start of the test period shall be considered at that instant when the last of the controls is operated to begin the air conditioning system.

5.1.6.4 *Interim record*

During the test, the temperatures at all the occupants' nose levels shall be recorded at intervals not exceeding 5 min maximum. The lower limit for the sampling time shall be decided based on the sensitivity and response of the temperature measuring sensor and the capability of the recording equipment.

5.1.6.5 *Cabin temperature*

The average of all nose level temperatures at the end of specified time shall be taken.

5.2 Heating Test

This test is carried out to obtain the cabin temperature variation under steady state operation of the heating system.

5.2.1 *Vehicle Preparation*

Sensors, such as thermocouples for recording temperatures nose and feet levels of all occupant seating positions shall be fitted with recording instruments having an accuracy of ± 1 °C.

5.2.2 *Test Location*

Test shall be carried out either in a climatic chamber with controlled conditions or on road as per the test cycle mentioned in Annex B.

Test location for on road test to meet required test conditions as mentioned in Annex B.

5.2.3 *Test Cycle*

Test cycle as mentioned in Annex B to be followed.

5.2.4 *Vehicle Setup for Climatic Chamber Test*

The vehicle setup shall be done as follows:

a) Vehicle shall be parked in a climatic chamber at temperature mentioned as per Table 3 of Annex B with all doors and windows open;

b) Driver and co-driver seat setting:

    1) Back rest of seat shall be back one notch from vertical; or

    2) Arm rest shall be down; and

c) Vehicle should be kept inside climatic chamber with doors and windows open. Set chamber temperature as per Annex B. Once the required temperature is achieved inside climatic chamber vehicle shall be soaked till the coolant temperature reaches within ± 2 °C of the set conditions.

5.2.5 *Vehicle Setup for Road test*

The vehicle setup shall be done as follows:

a) The vehicle shall be parked in an open area free from structures at start point of test in the evening prior to the day when the test has to be conducted;

b) The vehicle shall be positioned facing the start point of road in such a way to ensure that it can be run without hindrance during the test;

c) All the doors and windows of the vehicle shall be shut; and

d) The vehicle shall be left undisturbed in this position for a duration till the coolant temperature stabilized within ± 2 °C of the ambient condition and this period shall be considered as the soaking period.

5.2.6 *Testing*

5.2.6.1 *Initial recording*

Once the soaking condition is achieved, record initial readings of all the temperatures at all occupants face and feet level just before personnel entry.

5.2.6.2 *Start of test*

After the soaking period as mentioned in Annex B, the testing personnel shall enter the vehicle and all doors and windows shall be closed. For road test the total number of occupants during the test shall be not less than two in case of *M1, N1, N2,* and *N3* and three for *M*2 and in no case exceed the maximum seating capacity of the vehicle.

5.2.6.3 *Running*

The vehicle shall be started and immediately the heating system shall be switched on and the controls are set as per **4.2** d) to **4.2** f). The vehicle shall be driven as per the test conditions specified in Annex B. The start of the test period shall be considered at that instant when the last of the controls is operated to begin the heating system.

5.2.6.4 *Interim recording*

The temperatures at all the occupants' nose and feet levels shall be recorded at intervals not exceeding 5 min maximum. The lower limit for the sampling time shall be decided based on the sensitivity and response of the temperature measuring sensor and the capability of the recording equipment.

5.2.6.5 *Cabin temperatures*

The average of all face and feet level temperatures at the end of specified time to be checked.

6 ADDITIONAL MEASUREMENTS FOR DIAGNOSTICS

During the test, the following additional parameters may also be monitored.

6.1 Air Conditioning System Cut-in/Cut-off

The cycling of the air conditioning system cut-in/cut-off shall be monitored and can be analyzed for identifying the cause of the system tripping. The arrangement used for monitoring, this shall be such that it does not interfere electrically or otherwise, with the normal functioning of the air conditioning system.

6.2 Air Temperatures at Outlets and Inlets

Additional temperature sensors may be used at all the air outlets to study the availability of cool and hot air and any imbalance in the temperature distribution among the outlets. These, in addition to the temperatures at the blower inlets, would help in identifying sources of external air infiltration.

ANNEX A

(*Clause* 5.1)

COOL DOWN TEST CONDITIONS

Table 1 Test Conditions

Sl No.	Requirement	Road / Climatic Chamber		
(1)	(2)	(3)		
i)	Ambient temperature (°C)	40 or more		
ii)	Relative humidity (percent)	More than 30		
iii)	Solar load (W/m^2)	More than 800		
iv)	Soaking duration (minutes)	Time to reach at least 15 °C more than ambient (that is, 55 °C average nose temperature at 40 °C ambient) and shall be more than 1 h.		
v)	Vehicle running condition during test	Vehicle and wind speed (kmph)	Gear position	Duration (min)
		Table 2, requirement a	As specified by the manufacturer	20
		Table 2, requirement b		20
		0	Neutral	20

Table 2 Vehicle Speed

(*Table* 1)

Sl No.	Vehicle Category	a (kmph) (*) Road/Climatic Chamber	b (kmph) (*) Road/Climatic Chamber
(1)	(2)	(3)	(4)
i)	*M1, M2*	50 ± 5	80 ± 5
ii)	*N1*, *N2* and *N3*	40 ± 5	60 ± 5

(*) Vehicle speed selection as per the table or lower depending on the speed limit restrictions

ANNEX B

(*Clause* 5.2)

HEATING TEST CONDITIONS

Table 3 Test Conditions

Sl No.	**Requirement**		**Road/Climatic Chamber**	
(1)	(2)		(3)	
i)	Ambient Temperature (°C)		Ambient less than 5	
ii)	Soaking		Till coolant temperature stabilizes ± 2 °C of ambient temperature	
iii)	Vehicle running condition during test	Vehicle and wind speed (kmph)	Gear position	Duration (minutes)
		Table 4, requirement a	As specified by the manufacturer	40
		0	Neutral	20

Table 4 Vehicle Speed

(*Table* 3)

Sl No.	**Vehicle Category**	**a (kmph) (*) Road/Climatic Chamber**
(1)	(2)	(3)
i)	*M1, M2*	50 ± 5
ii)	*N1*, *N2* and *N3*	40 ± 5

(*) Vehicle speed selection as per the table or lower depending on the speed limit restrictions.

ANNEX C

(*Foreword*)

COMMITTEE COMPOSITION

Refrigeration and Air Conditioning Sectional Committee, MED 03

Organization	*Representative (s)*
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